

IV.

ON PLANTATIONS OF SCOTCH FIR ON MOORPAN SOIL.

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Moorpan presents in the lowlands of the north of Germany, one of the most formidable obstacles towards the cultivation of the soil as forest land, with which the forester has to contend.

It occurs in the sandy low-lying countries, as a hard, sometimes solid and compact formation, often extending great distances without intermission.

It is either of a reddish black or of a yellow colour.

The depth at which the strata are found beneath the surface varies generally from one to two feet, but extends even to four feet.

The thickness of the strata varies from a half to 12 inches and even more, but is as a rule between three and six inches.

Moorpan is composed principally of sand, (80 to 90%) which is firmly cemented by heather humus. It contains also a slight percentage of iron sesqui-oxide and of aluminium silicate, and there are also traces of phosphoric acid. These with the large percentage of sand already stated constitute its component parts.

The nature of the layer differs very widely, sometimes it is so hard that it is necessary to use the pickaxe to break through it, at other times the spade is sufficient, and if the stratum does not lie too deep the plough can often be employed with success.

After the moorpan has been brought to the surface and exposed to the influence of the weather particularly that of frost, it resolves itself into earth, sometimes within the space of a year, but when the layer is very hard and massive the process of "weathering" may last for several years. For instance, we saw in the forest of Nienburg, where the ground had been trenched, the moorpan still lying upon the surface quite "unweathered" after having withstood the atmospheric influence for three years, while in other places in the same forest, cultivated at the same time, the "weathering" had taken place so thoroughly that the presence of moorpan could only be detected by the brown colour of the sand.

Moorpan belongs to the present geological period, and is being formed, if the circumstances admit, to this day. In the neighbourhood of Nienburg there are great numbers of ancient tombs, which are often dug up in the process of cultivation, and the urns which are found in them are all encrusted with moorpan.

Moorpan is only to be found in a sandy soil where heather is growing or has grown and never in a loamy soil, even if heather has grown upon it for centuries.

Moorpan is found in the more elevated as well as in the lower situations of the plains, but principally in the former, where on account of the dryness of the soil the heather humus is even harsher than usual.

As a rule the moorpan is only to be found where the common heather (*Calluna vulgaris*) grows, but it also occurs in some places where the bog heather (*Erica Tetralix*) thrives.

Tracts from which the heather has been for a long time cleared, to be used as manure, have generally a thinner stratum of moorpan than those on which it has been allowed to grow unmolested.

As a rule a yellow coarse-grained sand lies underneath the moorpan, it is therefore easy to check the work done, as if the layer has been thoroughly broken through, this sand must appear.

In some places the moorpan occurs more broken and in patches and the woods growing upon such ground present in general a very fair growth and appearance as the roots find their way through the crevices and interstices. We had an opportunity to see such a wood in the Nienburg forest, and although the growth of the trees was good, the formation of the roots seen on some trees torn up by the wind, was very peculiar and had the appearance of a broom.

Forests standing upon really firm moorpan impenetrable for the roots, have, without exception, a perfectly distorted, crippled, and unhealthy appearance.

In districts where the moorpan is kept continually moist and soft through the influence of ground water, the deep searching roots of the Scotch fir are able to penetrate through the stratum and as we saw in a neighbouring forest, the trees growing on this sort of soil have such an increase and healthy appearance that it is almost impossible to believe that moorpan exists here. In such districts this degree of dampness must be carefully preserved, for experience has shown that in woods of this description when the soil has been drained, the increase of growth has almost imme-

diately ceased, and the trees have assumed an unhealthy appearance.

For all this it is a fact beyond doubt or dispute that wherever moorpan is found, however thin the stratum may be, it always presents an obstacle towards the rearing and growth of trees, and unless the soil has been properly prepared beforehand the sowing or planting the same may be regarded as more or less useless, especially as the sandy soil, under which alone moorpan is to be met with, is only adapted to the growth of the Scotch fir, whose deep penetrating tap-root is not capable of breaking through the stratum. With few exceptions only cripple and dwarf woods are to be met with on moorpan when the soil has not been properly prepared. Even in its youth the presence of moorpan can be immediately detected by the shrub-like and unhealthy appearance of the Scotch fir, its short terminal shoots, and by the thin and scanty growth of the leaves, which are also of a yellowish colour; such a wood is the favorite resort of the different species of *tortrix*, and soon falls a prey to their ravages.

In cases of this kind there is no choice left to the forester. He must either cut down the whole wood, trench the soil, and plant afresh, or else he must cut lines of about six feet in breadth and at from six to eight feet apart through the wood and trench the so-cleared strips. We saw an experiment of the latter method, which had been carried out three years ago. The remaining trees had, through the influence of the air, which had now free access, considerably recovered, their terminal shoots were at once longer and their leaves grew thicker and presented a more normal appearance. In course of time also the roots find their way to the trenches where they are enabled to go deeper down for nourishment.

In the low-lying countries where moorpan occurs it is of the greatest importance that the forester should examine the ground carefully and attentively, especially tracts of heather, before he cultivates; to do this he must let the ground be dug in different places to ascertain the thickness of the moorpan stratum and the depth at which it lies, in order from those data to determine what mode of cultivation should be adopted.

In the province of Hanover, where thousands of acres of heather wastes have been purchased by the Government in the last few years, it was especially necessary to examine the ground carefully, as the expensive nature of the cultivation of moorpan has, of course, a very material influence

on the value of the land. The average price of such land was from 24*s.* to 30*s.* per morgen,* varying according to the depth at which the moorpan lay and the thickness of the stratum.

With regard to the component parts of moorpan experience has shown that when "weathered," they exercise a very favourable influence on the growth of trees, and the moorpan should therefore never be removed from the cultivated tract. We saw two adjoining pieces of land, on one of which the moorpan had been left, and from the other removed. The growth of the Scotch fir was much better on the former. Moorpan is destructive to the growth of trees simply because their roots cannot pierce through it, and because it entirely hinders the beneficial influence of water between the upper and lower ground. It is especially prejudicial by long-continued drought, as the ground moisture is unable to pass through the stratum to the surface.

To the question if, after being once broken up, the moorpan is again formed there is no definite or decided experience to reply. It can be fairly supposed though, that if on a tract which has been once cultivated the heather is again allowed to grow unopposed moorpan will again be formed, but that, on the contrary, on tracts which are regularly planted and cultivated its formation cannot take place.

Sufficient has been said to show that it is absolutely necessary to break through the moorpan if planting is to be carried on with success.

The methods of cultivation differ widely and are dependent upon the depth at which the moorpan lies and the structure of the stratum.

• Where the layer lies two feet or more deep it must be broken through with pick-axe and spade. This is the most costly method and entails an outlay of from 30*s.* to 3*l.*, according to the hardness and depth of the stratum, to trench a morgen, the trenches being the same width as the spaces between them; in reality, therefore, only half of the morgen is cultivated.

Should a still larger outlay be required it is very questionable if it is judicious to cultivate at all. Small wastes in the middle of a forest might justify such an outlay, and in such places even more than 3*l.* might be expended in order to make the forest compact.

The trenches are, as a rule, six feet broad and six feet apart. The manner of proceeding is the following:—After

One Hanoverian morgen = 0·6477 of an English acre.

the trenches are marked out by means of a line, the workman throws the earth out of a part of the trench until the moorpan is also thrown up on the surface, then going backward, he fills the hole thus made with the earth won from the next part, and so on until the trench is finished. In this manner the surface earth is thrown in first and the moorpan on the surface. It is of the utmost importance to control this work carefully, as it is only given by the job, and the workmen are therefore apt not to break through the stratum thoroughly. As it is impossible, when extensive areas are under cultivation, to be constantly superintending the work, the trenched ground is afterwards examined with the so-called moorpan-searcher in order to see if there is any part of the stratum still underground. This instrument is a simple bar of iron five feet long and half an inch thick, sharpened at the point and furnished with a handle.

In places where the stratum lies deeper, and where the outlay incurred by this manner of trenching would bear no proper proportion to the receipts gained by the first felling, a different and less expensive method is used, called in German "*rabatten-cultur*." The process is the following:—Ditches of from four to six feet breadth are dug at a distance of from 12 to 16 feet apart; the contents of the ditches are thrown upon and equally spread over the broad undug beds with the moorpan on the top. By this means the beds or *rabatten* are considerably raised, and the plants placed on them have therefore a deeper soil, the stagnation of the upper ground water is prevented, the atmosphere is enabled through the open ditches to act on the remaining moorpan, and thus cause it more or less to "weather," and the unfavourable influence of the formation on the growth of plants is greatly diminished.

In order to save expense experiments have also been made by means of turning up the ground in holes of four feet square, the squares four feet apart from one another, but it has been found that the trenches and *rabatten* are much superior, as the plants on them have more growing room, and as the luxuriant growth of the heather encroaching from four sides is apt to choke the plants growing on the squares. The cost of this method averages from 24s. to 30s. per morgen.

Sowing was formerly almost without exception the rule, with from four to five pounds of Scotch fir seed per morgen. Latterly planting is the only method in use, unless it is an object to grow at the same time material for planting elsewhere, and thus cover part of the expense of a nursery.

According to the experience gained in the Nienburg forest planting with strong healthy one-year old Scotch fir has had by far the most favourable result. Plantations made with plants older than one year, as well as those grown from seed, have not the same favourable growth. The one-year old plants are reared on deeply trenched seed beds manured with the humus of *Calluna vulgaris* and *Vaccinium Myrtillus*, which has been brought some years before into heaps and been constantly turned. In this manner, unless the weather is very unfavourable, healthy strong plants are reared. The six feet broad trenches are planted with three rows of Scotch fir, the distance between them in the rows being three feet. Care should be taken to plant the two side rows as near as possible to the untrenched space, in order to favour the closing of the plants as soon as possible over the whole area. As it is most desirable to bring about the closing of the plants as soon as possible a row of Scotch fir can also be planted down the middle of the untrenched space at a distance of from five to six feet of each other. Of course those plants cannot have the same growth as those on the trenched ground, but it is undeniable that they also profit from the cultivation, and that the closing of the wood is greatly furthered by them.

The cultivation of the spruce fir, the Weymouth and Austrian pine has also of late years been tried; all three have up to the present grown well, but whether they will continue to do so is a question for the future to answer. The Austrian and Weymouth pine require the least anxiety, and even if the spruce does not grow well it will still be very beneficial as a protection to the soil under the Scotch fir. The squares which have already been mentioned are planted with one-year old plants; four or five on a square.

Where the ground is free from roots &c., and not too uneven, and where the moorpan layer does not lie too deep, at the most 18 inches beneath the surface, the plough can be used with effect.

If the ground is covered with scrub or strong heather it must first be cleared.

We had a good opportunity of seeing this manner of cultivating in the Lunenburg Heath, where it was being carried out on a large scale. Formerly a so-called underground plough was used, but as it sprang too easily over hard moorpan without raising it, it has of late years been superseded by the sowing plough.

The sowing plough has in front a small wheel which can be raised or depressed at pleasure according to the depth

of ground the plough is meant to turn up. The plough should be longer and narrower than usual when it is required to go very deep, as one of such a construction passes more readily through the moorpan. The coulter must be high, and swung in such a manner that both earth and moorpan are completely thrown up.

A vigilant supervision is very necessary, and it must be seen to that the yellowish coloured sand lies on the surface.

Two furrows must first be ploughed with the common agricultural plough, the sowing plough then enters and turns up the second furrow. A third is then ploughed with the common or fore plough followed by the sowing plough, and so on.

In order to save expense, strips eight feet in breadth at a distance of six feet from each other are as a rule ploughed.

When the moorpan does not lie deeper than 12 inches, a pair of horses is sufficient, and the expense is about 27s. pro morgen; if the stratum occurs at a depth of from 14 to 18 inches six horses are necessary, and the cost is about 54s. pro morgen.

18 inches is the maximum depth at which the layer may lie if the ploughing is to be done effectually.

Ploughing is only done by the job.

The ploughs are furnished by the Forest Department, but the contractor is responsible for repairs and the cost of transport.

When the ground has been sufficiently exposed to the atmosphere the sowing or planting is carried out in a manner similar to that already described.